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14. ABSTRACT

Purpose: The purpose of this study is to determine the effect of cigarette smoking on wound healing and rehabilitation among service members who have a traumatic lower extremity amputation. **Design**: This study uses a prospective quasi-experimental arm and a retrospective chart review arm. **Methods**: Each arm compares the difference over time between smokers and nonsmokers healing time and length of time to progress through a rehabilitation program. **Sample**: The sample included active duty service members who experienced a traumatic amputation. The prospective arm required enrollment within one month of the injury. The retrospective review included only those that were seen at the Center of the Intrepid in San Antonio, Texas and captured in the clinical database. **Analysis**: A t-test was used to compare differences in days between smokers and nonsmokers from initial amputation until the amputation was deemed healed. Rehabilitation was analyzed using a t test to compare smokers to nonsmokers to determine differences in number of days from the date of injury to each of four phases of rehabilitation. **Findings**: The overall smoking rate was 38.1%. Smokers had a significant delay in wound healing taking an average of 51.2 more days to heal when compared to nonsmokers. No difference was found in the number of days for rehabilitation or the distance walked in a 2 minute walk test when comparing smokers to nonsmokers. **Implications for Military Nursing**: Critically injured service members who smoke are at risk for complications. Nurses are the patient advocates to guide these patients through the entire pathway of healing and rehabilitation. Nurses are also essential personnel in the current smoking cessation programs for the military. Nurses must advocate for smoking cessation to insure the best outcomes for these war fighters.

15. SUBJECT TERMS

wound healing, rehabilitation, smoking cessation programs, traumatic lower extremity amputation

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Abstract.

Purpose: The purpose of this study is to determine the effect of cigarette smoking on wound healing and rehabilitation among service members who have a traumatic lower extremity amputation.

Design: This study uses a prospective quasi-experimental arm and a retrospective chart review arm.

Methods: Each arm compares the difference over time between smokers and nonsmokers healing time and length of time to progress through a rehabilitation program.

Sample: The sample included active duty service members who experienced a traumatic amputation. The prospective arm required enrollment within one month of the injury. The retrospective review included only those that were seen at the Center of the Intrepid in San Antonio, Texas and captured in the clinical database.

Analysis: A t-test was used to compare differences in days between smokers and nonsmokers from initial amputation until the amputation was deemed healed. Rehabilitation was analyzed using a t test to compare smokers to nonsmokers to determine differences in number of days from the date of injury to each of four phases of rehabilitation.

Findings: The overall smoking rate was 38.1%. Smokers had a significant delay in wound healing taking an average of 51.2 more days to heal when compared to nonsmokers. No difference was found in the number of days for rehabilitation or the distance walked in a 2 minute walk test when comparing smokers to nonsmokers.

Implications for Military Nursing: Critically injured service members who smoke are at risk for complications. Nurses are the patient advocates to guide these patients through the entire pathway of healing and rehabilitation. Nurses are also essential personnel in the current smoking cessation programs for the military. Nurses must advocate for smoking cessation to insure the best outcomes for these war fighters.

TSNRP Research Priorities that Study or Project Addresses

Primary Priority

Force Health Protection:	Fit and ready force Deploy with and care for the warrior Care for all entrusted to our care
Nursing Competencies and Practice:	Patient outcomes Quality and safety Translate research into practice/evidence-based practice Clinical excellence Knowledge management Education and training
Leadership, Ethics, and Mentoring:	Health policy Recruitment and retention Preparing tomorrow's leaders Care of the caregiver
Other:	(Deployment Health)

Secondary Priority

Force Health Protection:	Fit and ready force Deploy with and care for the warrior Care for all entrusted to our care
Nursing Competencies and Practice:	Patient outcomes Quality and safety Translate research into practice/evidence-based practice Clinical excellence Knowledge management Education and training
Leadership, Ethics, and Mentoring:	Health policy Recruitment and retention Preparing tomorrow's leaders Care of the caregiver
Other:	(Military Clinical Practice & Outcomes Management)

Progress Towards Achievement of Specific Aims of the Study or Project

Findings related to each specific aim, research or study questions, and/or hypothesis:
This study required enrolling a very precise sample from a limited population. To measure healing, this study needed to enroll service members relatively soon after experiencing a traumatic amputation. As will be explained later in this report, predictably tracking the service members with a traumatic amputation became difficult and therefore sampling for the specific inclusion criteria for this study proved exceptionally trying. Ultimately, this study was not successful in meeting recruitment goals. Due to the various but significant recruiting challenges discussed below, only 22 SMs of the predicted 100 were enrolled: 7 current smokers, 1 quitter, and 14 nonsmokers. One smoker was subsequently disenrolled due to medical and psychological issues which complicated his care and made him inaccessible to the study team. In an attempt to overcome this sampling shortfall, a second recruiting site was established as well as receiving approval for a retrospective arm. Unfortunately even with all these attempts to boost enrollment, only eight individuals who had quit smoking were identified. This low number of SMs identified as quitters provided insufficient power for conducting statistical analysis and precluded further analysis of this category. Therefore, the analysis of the data will focus on the differences found between the two categories of smoker and nonsmoker. Each research question is listed below. Research questions which stated "smoking cessation" will be changed to read "smoking" for analysis.

Demographics:
The final sample (n = 253) was predominately married (52.6%), Caucasian (76.1%) males (98.4%) in the Army (79%) with a rank of E6 or below (87%). The average age was 31.9 (SD 5.8) with most experiencing an amputation as a result of an explosive device (79%). In this sample, 38.1% were identified as smokers.

In the final sample there was no statistically significant relationship between smoking status and gender, age, ethnicity, or service. A significant difference was found between smoking status and rank with junior enlisted being more likely to be smokers than all other groups (Cramer's V 0.236, $p>.01$) which is consistent with the literature.[1]

Table 1. Demographics for Prospective, Retrospective and Total Sample

	Prospective Sample	Retrospective Sample	Total Sample
	Frequency (Percent)	*Frequency (Percent)*	*Frequency (Percent)*
Gender			
Male	21 (100)	227 (98.3)	249 (98.4)
Female	0	4 (1.7)	4 (1.6)

Ethnicity			
Caucasian	19 (90.5)	172 (74.5)	191 (76.1)
Black	1 (4.8)	20 (8.7)	21 (8.3)
Asian	0	4 (1.7)	4 (1.6)
Native American	0	2 (0.9)	2 (0.8)
Hispanic	1 (4.8)	32 (13.9)	33 (13.1)
Other or Mixed Heritage			
Service			
Army	14 (66.7)	185 (80.1)	199 (79.0)
Air Force	1 (4.8)	11 (4.8)	12 (4.8)
Navy	0	7 (3.0)	7 (2.8)
Marine Corps	6 (28.6)	28 (12.1)	34 (13.5)
Rank			
E1 to E4	17 (77.2)	110 (47.7)	127 (50.2)
E5 to E6	2 (9.1)	92 (40)	94 (37.2)
E7 to E9	0	12 (5.3)	12 (4.7)
Officers	2 (9.0)	16 (6.9)	20 (7.9)
Mechanism of Injury			
Explosive device	17 (81.0)	183 (79.2)	200 (79.4)
Gunshot wound	1 (4.5)	15 (6.5)	16 (6.3)
Motor vehicle accident	2 (9.1)	18 (7.8)	20 (7.9)
Crush injury	0	8 (3.5)	8 (3.2)
Aircraft accident	0	2 (0.9)	2 (0.8)
Machinery/equipment	0	1 (0.4)	1 (0.4)
Other	1(4.5)	4 (1.7)	5 (2.0)
Marital Status			
Single, never married	7 (33.3)	69 (29.9)	77 (30.7)
Married	12 (57.1)	120 (51.9)	132 (52.6)
In a relationship	1 (4.8)	37 (16.0)	38 (15.1)
Divorced	1 (4.8)	3 (1.3)	4 (1.6)
Smoking Status			
Non-smoker	14 (63.6)	129 (55.8)	143 (58.6)
Smoker	7 (31.8)	86 (38.7)	93 (38.1)
Quitter	1 (4.5)	7 (3.2)	8 (3.3)

Research Questions:

Research Question 1a: What effect does smoking have on wound healing (days until healed) of lower extremity amputee service members?

Wound healing was measured in days from the date of the initial injury until the date the wound was documented as healed. The documented healed date was determined in the

prospective arm by two blinded photographs. A photograph of the wound was taken upon participant enrollment and another photograph was taken on the date the wound was considered healed. Both de-identified photographs were sent to a blinded orthopedic physician for an independent determination. There was a 100% agreement in this study between the wound care specialist and the blinded orthopedic physician on the healing dates of the amputations. The date the wound was healed was determined in the retrospective arm based upon documentation. This date was felt to be accurately documented due to the need for complete healing prior to prosthetic weight bearing.

The prospective sample found that on average, smokers required almost 42 more days to heal when compared to nonsmokers (133.8 days vs. 91.9 days respectively). When combined with the retrospective data this difference also held with smokers requiring an average 51.2 more days to heal compared to nonsmokers (156.6 days vs. 105.7 days respectively). However, this data was negatively skewed and required a log transformation in order to satisfy normality rule to run a t test. Once the log transformation was complete and the skewness was confirmed to be less than 1, a t-test was run. The t-test demonstrated that smokers take significantly longer to heal when compared to nonsmokers with similar injuries ($p<.05$).

Table 2: Days until wound healed

	Category	n	mean	Days to healed	p value
Prospective Sample	Smoker	5	133.80	51.28	
	Nonsmoker	10	91.90	22.65	
Combined Sample	Smoker	55	156.60	147.33	
	Nonsmoker	85	105.74	97.39	
Log Transformed	Smoker	55	2.05	.34	
	Nonsmoker	85	1.88	.35	.005

Aim 1b: What effect does smoking have on wound infections (<10 ASEPSIS) of lower extremity amputee service members?

This question could not be answered in the manner posed. To avoid additional risks to the participant by exposing the wound excessively, the protocol was written so all measurements would be conducted only when the patient was already undergoing a dressing change with the Wound Care Specialist. It was anticipated that the wounds of amputees would require regular dressing changes to evaluate the surgical site of the significant and complex injury and repair. The ASEPSIS tool which was chosen for this study to evaluate wound complications requires daily wound checks for the first 7 days after surgery. However, what was discovered upon initiation of the protocol was the dressing changes did not occur daily as required by the tool. Dressing changes were variable between patients as well as within each patient. Therefore the researchers did not have access to the wounds at the required time points to gather data for this tool as required. Attempting to use inconsistent time points with this tool would have invalidated

the tool results and therefore could not be used in this study. This is discussed in more detail under "Effects of problems on the results":

Aim 1c: What effect does smoking have on tissue perfusion (change over time in mean perfusion) of lower extremity amputee service members?

Tissue perfusion was measured using a laser Doppler. It is not dissimilar to a pulse oximeter but with two distinct differences. It measures light scatter that returns to the original sensor and therefore can be used anywhere there is skin exposed. The second significant difference is the laser Doppler does not provide percent oxygen saturation of the tissue. The numerical result of a laser Doppler measurement is a mathematical number that has no translation to clinical application. The Doppler measurements are compared to each other to determine increased or decreased perfusion but cannot be interpreted beyond that comparison. The laser Doppler was chosen as a tool for this study because it is frequently used to determine viable tissue through perfusion measurements in patients with serious burns.

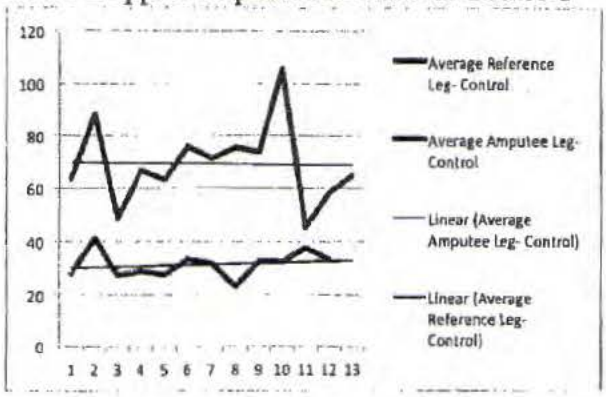
The laser Doppler results show that on average the limb with the amputation had a significant twofold increase in circulation when compared to the non-injured limb within both nonsmoking participants and smoking participants. A comparison between smokers and nonsmokers found no significant difference in circulation between either the leg with the amputation or the comparison leg. (Table 3) Among the non-smoking group, the limb comparisons remained relatively constant throughout the measures. (Graph 1) Interestingly, among the smokers the elevated level of perfusion in the amputated limb steadily declined over the course of the study until the lines began to intersect. (Graph 2) The comparisons between groups do not show a significant difference when comparing either the reference legs or the legs with an amputation. (Graphs 3 & 4) It is interesting to again note that the laser Doppler readings for non-smokers remained relatively constant for both limbs whereas the laser Doppler readings showed a downward trend for both injured and uninjured limbs.

Table 3. Average Laser Doppler by Smoking Category and Limb Type

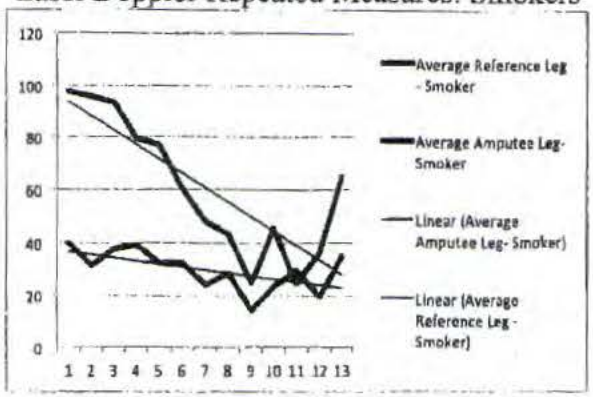
	Mean perfusion	SD	sig
Nonsmoker			
Reference limb	31.50	4.93	
Amputated limb	69.89	16.43	<.05
Smoker			
Reference limb	29.85	7.76	
Amputated limb	60.93	26.14	<.05
Comparison: Reference limb			
Nonsmoker	31.50	4.93	
Smoker	29.85	7.76	ns

Comparison: Amputated limb			
Nonsmoker	69.89	16.43	
Smoker	60.93	26.14	ns

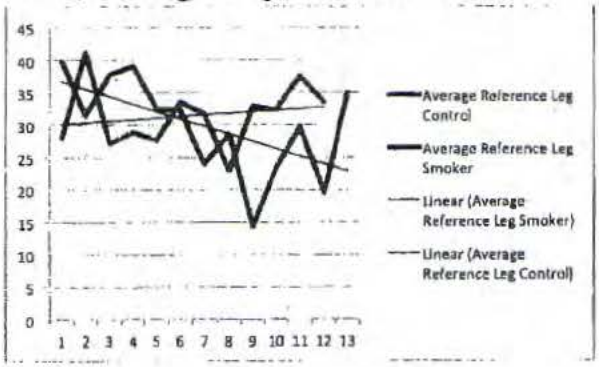
Graph 1
Laser Doppler Repeated Measures: Controls



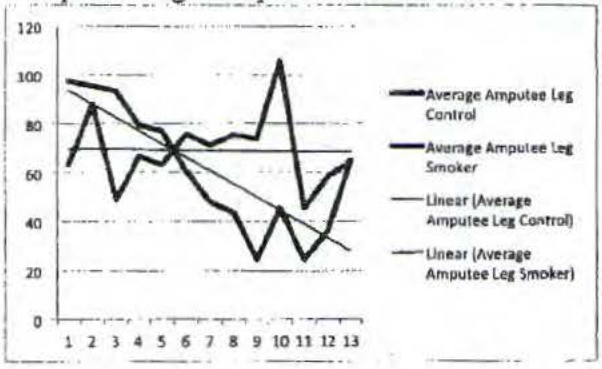
Graph 2
Laser Doppler Repeated Measures: Smokers



Graph 3
Reference Leg Comparison Control vs Smoker



Graph 4
Amputee Leg Comparison Control vs Smoker



Aim 2a: What effect does smoking have on rehabilitation distance walked (2MWT) of lower extremity amputee service members?

The two minute walk test (2MWT) measures the total distance walked within two minutes and is rounded to the nearest meter. Research conducted previously on transtibial amputees showed an average distance covered in two minutes to be between 121 to 141 meters. This test is not considered standard of care for this population so the only data available to evaluate this question is from the prospective arm.

No statistical difference in distance walked was found between smokers and nonsmokers administered the 2MWT in ether the pre-rehabilitation or post-rehabilitation phases. Further, no statistical difference was found in the average improvement in distance walked between the pre and post rehabilitation phases. (Table 4)

There is sufficient literature to expect smokers to have performed worse on this test of cardiorespiratory fitness than nonsmokers. A possible confounder is the small sample that contributed to the large standard deviation which potentially masked a difference. It is interesting to note that smokers did show less cardiorespiratory fitness in the pre-rehabilitation testing but

essentially resolved that difference by the end of rehabilitation. In fact, the smokers improved almost twice as much as the nonsmokers in this small sample. This finding is intriguing and bears closer scrutiny in future studies to see if this finding holds in larger samples of active duty service members. This anomaly is also reflected in the next question.

Table 4. Comparison between smokers and nonsmokers in the 2 minute walk test

	Smoking status	N	Mean Distance	SD	sig
Average distance pre-rehab	Nonsmoker	5	163.19	36.71	
	Smoker	8	146.08	36.87	ns
Average distance post-rehab	Nonsmoker	6	191.80	23.79	
	Smoker	4	195.57	13.89	ns
Overall mean difference between pre and post rehabilitation	Nonsmoker	4	29.06	17.37	
	Smoker	4	63.18	38.99	ns

Aim 2b: What effect does smoking have on rehabilitation progression (days until milestones met) of lower extremity amputee service members?

Rehabilitation for amputees progresses along a programmed course of phases. The four phases are dictated by the condition of the stump as well as the person's progress. The phases are mutually exclusive although transition from one phase to the next might be subjective at times. Five points in time were used to calculate this Aim. Date of injury (DOI) is the documented date of original amputation. The first day that the rehabilitation team begins work with the patient is considered start of Phase I, which typically occurs while the service member is still hospitalized. This phase involves range of motion exercise, contracture prevention, edema control, and wheelchair mobility. Phase II begins when the rehab team moves to conducting pre-prosthetic training such as core strengthening, strength training and cardiovascular endurance. This also includes gait training on crutches and balance training. Phase III begins with the fitting and weigh bearing on a prosthetic device. This phase includes skills necessary for every day such as stumble recovery, walking on uneven terrain, gait testing, and frequent socket changes as the stump continues to remodel to weight bearing. Phase IV is the transition from ADLs to a higher level of functioning. In Phase IV such skills as skiing, biking, horseback riding and common soldier tasks are taught. This phase moves the service member from a basic level of mobility to a high level of fitness and mobility. The date on which each participant entered a new phase is used to calculate progression through rehabilitation. The difference, in days, is then calculated to determine time to progression to the next level of rehabilitation. These key transition points can be seen in the medical documentation. However, not all records included sufficient language to identify a specific date between transitions. The data used to complete this analysis includes both prospective sample and that portion of the retrospective sample where the transition dates could be identified.

On average, nonsmokers took about 15 days less than smokers to transition through all phases of rehabilitation. (Table 5). The only phase which smokers transitioned quicker was between phase III and phase IV. As this is the phase which moves the injured service member from normal ADLs to higher functioning independence, this is likely also a reflection of the "catch up" in cardiovascular fitness which was seen in the 2 minute walk test.

Table 5. Mean days to progress through rehabilitation stages by smoking status

	Smoking status	n	Mean	SD	Difference in days - smoker
Date of Injury to Phase I	Nonsmoker	37	161.35	195.91	
	Smoker	30	179.90	212.76	+18.55
Phase I to Phase II	Nonsmoker	31	23.39	16.45	
	Smoker	20	29.15	21.94	+5.76
Phase II to Phase III	Nonsmoker	59	15.46	11.81	
	Smoker	40	21.53	17.92	+6.07
Phase III to Phase IV	Nonsmoker	86	84.72	105.17	
	Smoker	50	69.70	55.36	-15.02
Date of Injury to Phase II	Nonsmoker	64	198.62	275.16	
	Smoker	45	213.67	238.70	+15.05
Date of Injury to Phase III	Nonsmoker	109	220.59	235.59	
	Smoker	71	303.73	318.70	+83.14
Date of Injury to Phase IV	Nonsmoker	95	304.36	266.32	
	Smoker	58	352.67	308.88	+48.31

The time in days between rehabilitation phases was negatively skewed and non-normally distributed. The data was log transformed to correct for skewness so statistical tests for significance could be conducted (Table 6). There was no significant difference found in the number of days between each of the rehabilitation phases by smoking group.

Table 6. Log Transformation of Time Between Rehabilitation Phases

	Smoking status	n	Mean	SD	
Date of Injury to Phase I	Nonsmoker	37	1.94	0.49	
	Smoker	30	1.96	0.52	ns
Phase I to Phase II	Nonsmoker	31	1.26	0.39	
	Smoker	20	1.37	0.33	ns
Phase II to Phase III	Nonsmoker	59	1.10	0.34	
	Smoker	40	1.23	0.34	ns
Phase III to Phase IV	Nonsmoker	86	1.70	0.46	
	Smoker	50	1.71	0.37	ns
Date of Injury to Phase II	Nonsmoker	64	2.06	0.42	
	Smoker	45	2.13	0.40	ns
Date of Injury to Phase III	Nonsmoker	109	2.18	0.36	
	Smoker	71	2.28	0.41	ns
Date of Injury to Phase IV	Nonsmoker	95	2.37	0.30	
	Smoker	58	2.42	0.33	ns

Relationship of current findings to previous findings:

Tobacco in the Military

Tobacco use in the military remains problematic. The prevalence remains high when compared to the civilian population (24% vs. 21.2% respectively) [2] and continues to be associated with attrition from basic training [3]. There is, however, some encouraging news. Comparing the DoD Health Related Behavior Surveys conducted in 2008 [4] and 2011 [2] an overall decrease in smoking is seen among active duty service members from 32% in 2005 to 24% in 2011. There was also a similar decrease in the number of self-identified heavy smokers between those years from 11% to only 3.2%.

Unfortunately this good news is tempered by new research which is beginning to show that military members who are deployed to a combat zone are at increased risk for both new and relapsed tobacco use. A study was conducted in 2008 using the Millennium Cohort which looked at a relationship between cigarette smoking and military deployment. [5] This study found that deployers were more likely to become smokers when compared to non-deployers (2.3% vs. 1.3%). Also among those smokers who had previously quit, there was more recidivism among the deployers compared to the non deployers (39.4% vs. 28.7% respectively). When the authors looked deeper into the data they found that those service members exposed to combat were at 1.6 times greater odds of initiating smoking from the previous group of never smokers. The risk of smoking initiation was also seen in another Millennium Cohort study conducted in 2011. Hermes

et al. [6] found a difference in smoking rates between those exposed to combat and those that were not. Current smoker prevalence increased from a rate of 12.9% among those not deployed, to 13.8% among those deployed without combat exposure to 17.7% among those deployed with combat exposure. A similar increase was seen among those who initiated smoking either through relapsing or initiation among those that did not deploy (7.9%), deployed without combat exposure (8.8%) and deployed with combat exposure (12.4%). A more limited study conducted by Talcott et al. [7] on Air Force Security Forces Airmen found similar increases in tobacco usage during the deployment. However, Talcott et al followed the Airmen through the post deployment phase and found a drop in tobacco usage upon return which in most cases fell below redeployment levels.

These more recent studies continue to show that tobacco prevalence in the military, that while it is decreasing, continues to remain higher than the civilian sector. This recent research has also begun to explore the more complex relationship between tobacco use and a combat environment. This would seem to hold true in this current study. The smoking rate of 38.1% is much higher than the 24% overall smoking rate. [2] More work will need to be conducted in this area in order to more clearly understand the relationship.

Impact of Tobacco on Wound Healing

The relationship between tobacco use and poor surgical outcomes is well established in the literature. As was discussed in the original proposal, research conducted on cellular response to tobacco smoke has uniformly shown decreased cellular activity and function. This has been demonstrated as less cellular migration to the wound, slower proliferation at the wound, and less collagen production for wound closure and remodeling. [8-11] A more recent study conducted on gingival cells confirmed these results with tobacco smoke causing less cellular viability, slower migration and less cellular differentiation. [12]

Studies conducted in vivo have also found similar results. Javed et al [13] conducted a literature review on the effect of cigarette smoking on periodontal surgical interventions and found all but one study showed worse healing among current smokers compared to nonsmokers. A second review of the literature by Gill, Yu and Neuhaus [14] conducted among patients having dermatological surgery found those patients who smoked were more likely to experience a higher incidence of postoperative complications including wound dehiscence, flap necrosis, prolonged healing time and infections. Sorensen [15] conducted a systematic review of 177 studies to evaluate the impact of smoking, smoking cessation and nicotine replacement therapy on wound healing and infections after surgery. This review found that smoking affects the tissue microenvironment and has a negative effect on inflammatory and reparative cell functions. Smoking cessation improves the microenvironment but the proliferative suppression remains. Nicotine replacement therapy seems to improve all markers but only by a marginal amount.

The literature remains clear that smoking continues to be associated with worse surgical outcomes. This review found that cessation and possibly nicotine replacement therapy may attenuate those negative effects some but more research is needed to further clarify.

Hospitalization and tobacco cessation:

As stated in the proposal, research has found advantages to quitting smoking either pre-hospitalization or even once hospitalized. The systematic review conducted by Rigotti, Munafo and Stead [16] published in the Cochrane Collaboration found that intensive counseling for smoking cessation which continued at least one month after discharge was able to maintain

cessation (OR 1.65, 95% CI 1.44 to 1.90). Those programs which had no post-hospitalization follow up and even those that offered pharmaceutical assistance without counseling found no significant difference in quit rates. A new systematic review conducted by Rigotti, Clair, Munafo, and Stead [17] found similar results. This study found that intense counseling both during and at least one month after hospitalization was necessary to see a significant difference in cessation rates compared to usual care. However, this study also found an increase in cessation rates when counseling was paired with nicotine replacement therapy. No difference was seen when bupropion or varenicline was added to intensive counseling.

Impact of Tobacco on Orthopedic Healing

Ample evidence is available to suggest tobacco smoke is detrimental to bone growth and healing. A literature review article by Fini et al [18] confirmed the cytotoxic effects of tobacco smoke on osteogenic activity which were also explored in the initial proposal. [19-21] Similar negative effects were found among in vivo research. Eleftheriou et al [22] evaluated the relationship between bone structure and geometry with smoking among 723 young British military recruits. Using DXA scans and MRIs the study found that smokers and recent quitters had significantly less bone density compared to nonsmokers and ex-smokers. Jeffcoach et al [23] found among those patients who had experienced a long bone fracture, smokers were 3.19 times more likely to experience a non-union/malunion complication when compared to nonsmokers. A systematic review conducted by Scolaro et al [24] also found smokers were 2.32 times more likely to experience a fracture nonunion when compared to nonsmokers. This review also found the mean healing time to be longer among smokers compared to nonsmokers (30.2 weeks vs. 24.1 weeks respectively).

A study by Nasell, Adami, Sanmegard, Tonneson and Ponzer [25] conducted a randomized prospective trial in which they enrolled smokers with an extremity fracture and randomized to a usual care or cessation intervention group. They found that among those that continued to smoke after the bone fracture were more likely to have a postoperative complication (38% vs. 20%, p=0.048) and also more likely to have two or more complications (p=0.039) compared to those who successfully quit smoking.

Two studies were found which discussed the impact of tobacco use on amputations which had been conducted for medical purposes. A study by Nguyen, Gordon, Walen and Wilson [26] found that a risk factor for a subsequent higher amputation was tobacco smoking for over 20 years. A more recent study by O'Brien, Cox, Shortell and Scarborough [27] evaluated 8,878 patients with lower extremity amputations due to medical causes. Among this sample, ongoing tobacco use was associated with early amputation failure which required subsequent surgery.

These findings remain consistent with those presented in the initial proposal. Two important notes with regard to the effects of tobacco smoke on orthopedic healing. There still were no published reports found for the effect of smoking on traumatic amputations. Of equal importance is the study by Nasell which found fewer healing complications among those that quit smoking after sustaining the injury. This is consistent with the findings of Sorensen, Karlsmark, & Gottrup [28] presented in the original proposal which found fewer surgical incisional complications among those smokers who quit after surgery. These studies both support the concept that at least some of the negative effects of smoking can be mitigated even after the injury has occurred if the person is willing to quit at that time.

Impact of Tobacco on Exercise and Rehabilitation

There were no new studies identified which evaluated the effects of smoking on exercise and rehabilitation among people with a traumatic amputation. However, as noted in the proposal, there is ample evidence which supports the negative impact smoking has on exercise and exercise tolerance and new studies continue to support this relationship. Mullie, Collee, & Clarys [29] evaluated the determinants of smoking and other health behaviors on physical activity among Belgian 5,000 service members. The study found that smokers were less likely to engage in vigorous physical activity (OR 0.83; CI: 0.65-1.06) but no difference was found for moderate activity. Macera, Aralis, MacGregor, Rauh, Han & Galarneau [30] evaluated 18,537 male U.S. Navy personnel who deployed to Iraq or Kuwait. This study found smokers could do fewer curl ups, fewer pushups and had a significantly slower 1.5 mile run when compared to nonsmokers. Additionally, over the course of the four year study, the study was able to show that smokers experienced a significant and progressively decreasing cardiorespiratory fitness compared to nonsmokers.

These studies all support previous knowledge that tobacco use is related to less physical activity. The study by Mullie, Collee, & Clarys shows in general terms what the study by Madera et al show specifically, smokers exercise less and have less exercise tolerance when they do exercise.

Effect of problems or obstacles on the results:

This study encountered a few obstacles as can be expected. The primary obstacle was the difficulty with recruiting. However, issues with the equipment and study procedures are also outlined below.

Recruitment

This study experienced exceptional difficulty in recruiting the intended sample. It was originally projected this study would prospectively enroll 15 service members in each of three categories: current smoker, SMs who have never smoked, and SMs willing to quit smoking once enrolled. Upon initial planning for this study the number of injured service members arriving to the Center for the Intrepid at Fort Sam Houston were determined. At that time, there were approximately three injured service members arriving each month. At that rate, new arrivals should have been about 36 per year or approximately 100 over three years. This was sufficient to meet the initial goal of recruiting 45 participants. Discussions with the research staff at the CFI concurred with this plan. The IRB at Fort Sam Houston subsequently requested this protocol increase enrollment to meet possible attrition in the smoking cessation arm. It was noted to the IRB the significant challenge this placed on recruiting given the relatively limited number of injured arriving to the CFI. However, given the continued large troop deployments to OIF and OEF, the recruiting numbers were still felt to be obtainable. Per the IRB request, the new enrollment goal was set at 100, 20 smokers, 20 nonsmokers and 60 quitters. The CFI viewed this new enrollment number challenging but still possible given the current influx of new injured service members.

Within the first year of recruiting, however, it became apparent that something had changed. The deployments to the Middle East were still on-going and there were still reports of injured service members returning but the numbers arriving at the CFI had decreased. Inquires discovered that the vast majority of the injured service members were being held at Walter Reed National Military Medical Center (WRNMMC) for treatment and were not being transferred to

the CFI. Investigation into why this was occurring was inconclusive. Due to this limited throughput of injured service members, recruitment remained low at the CFI over the remainder of the study. Many months would pass without an injured service member arriving to the CFI, and of those that did arrive, most arrived with healed wounds after having received initial treatment at WRNMMC.

Upon my arrival at USUHS, I began to explore the possibility of opening a second recruitment site at WRNMMC. The specialized amputee program at Walter Reed Military Advanced Treatment Center (MATC) had over 150 service members with amputations in active case management. Over the course of the next year I worked to build the infrastructure I would need to include recruiting a wound care specialist and a physical therapist to be on the study team. The WRNMMC site required more coordination due to the complexity of the site as well as the significant differences in clinical processes for the injured service members. After reviewing the budget, gathering all necessary letters of support and working closely with TSNRP and the Henry Jackson Foundation, I was able to open a second site at Walter Reed to enroll participants. However, this effort also failed to improve the recruiting situation. For reasons not well understood to myself or the Chief of MATC, the arrivals also dropped off dramatically at Walter Reed. In discussions with the Chief of MATC, he commented that he had never seen the influx of service members with amputees to be as low as it was during this period. He was unable to explain the reason. This stagnation of recruitment occurred after only three successful enrollments and approximately 10 months from the completion of the grant. Within six months of opening the MATC site, the Research Assistant for WRNMMC submitted her resignation after having accepted a more permanent position. Given the protracted time typically required to hire and orient a new research assistant, the declining numbers available to recruit, and only a few months left until the grant was closed, I decided not to re-hire into that position and to close the MATC recruiting site. At this point only 22 of the required 100 participants were enrolled and there was no new enrollment through the remainder of the grant period.

The unsuccessful recruitment has significant ramifications to this study. This study was designed to be prospective and predictive of outcomes. Service members were to be followed over time to monitor for wound healing, wound complications and rehabilitation progression. The limited prospective sample impedes any ability to predict outcomes and decreases the power to even determine group differences. The large variability in healing and rehabilitation rates within and between subjects also presents significant challenges in determining group differences with a low sample size.

This study sought to determine if smoking cessation after an injury might change the healing and rehabilitation trajectory. This required 20 prospectively enrolled participants to volunteer to quit smoking after enrollment. However, due to the poor prospective enrollment, too few participants were able to be enrolled which resulted in this important group failing to be represented in the final sample. While the literature continues to support this concept, it was not able to be tested in this study.

Methodology

Methodological change

In an attempt to rectify the recruitment concerns, a second arm was developed for the study. Adding a retrospective arm to this protocol was a calculated attempt to increase the sample size which in turn would increase the power to determine differences between groups. Altering a study method while it is underway has inherent risks. This step was taken only after it

became readily apparent the sample size would not be achieved within the time remaining in the grant. The administrative obstacles to accomplish this methodological change were relatively low and included gaining access to the dataset, applying for and receiving IRB and TSNRP permission to change the protocol, and insuring validity of data within the dataset. To offset these obstacles the expected benefit would be data triangulation and a larger sample size which would increase the power to determine differences between groups. These benefits were realized to the extent possible with the dataset.

Dressing changes

The protocol was written with the understanding that complex wounds susceptible to infection would require routine dressing changes. The protocol utilized tools which required regular wound assessment in order to evaluate for healing and the possibility of complications. However, what was discovered over the course of the study was that wound care advanced in this population just as advances were seen in the long term care of these injured service men and women. Routine dressing changes were no longer being done and each case was individualized according to the injury and the need of the wound. For this protocol, that meant irregular and somewhat unpredictable access to the wound and random ability to directly observe and record data. The tool chosen for this protocol to assess wound complication was the ASEPSIS tool. This tool requires daily access to the wound for post-op days 1 to 7. This proved impossible given that some did not even have a dressing change in that window according to their individualized care. Without these measurements the tool was not valid. Specifically written into the protocol was that the wound would not be exposed purely for research purposes to avoid any possibility of an increased risk of infection for study participants. The prolonged time between clinically indicated dressing changes coupled with the inability to use a scientifically predictable timeline for dressing changes resulted in the loss of this data collection tool. The impact of this was the loss of an objective and validated tool to assess complication rates.

The collection of complication rates was targeted toward the proposed third recruitment group of quitters. The hypothesis was that injured servicemen and women who quit while in treatment would have a lower complication rate compared to those who continued to smoke. A secondary outcome would have been to look at the differences in complication rates between smokers and nonsmokers. However, there is ample evidence which already exists that smokers have significantly more healing and rehabilitation complications when compared to nonsmokers. The loss of this data point in this protocol is unfortunate but lacking the third group, it is likely the results would have only confirmed what is already known; smokers have more post-operative complications compared to nonsmokers.

Equipment

Near the end of the second year the laser Doppler which was being used for data collection became inoperable. The equipment was on loan to us from the Institute of Surgical Research and had been purchased by them many years before. When the manufacturer was contacted the team was advised that the model was no longer being serviced. After negotiating with the manufacturer, TSNRP and Geneva a new laser Doppler was rented for the remainder of the grant. However, the new laser Doppler used a slightly different algorithm to calculate tissue perfusion which meant that directly comparing the output from the first laser Doppler with the new laser Doppler was not possible. The manufacturer worked with their software designers to create a formula which translated the original laser Doppler findings to the same formula as the

new laser Doppler used. This made comparison between the first recruits and later recruits possible.

While the equipment failure and subsequent issues with translating the data output caused temporary difficulties, it did not significantly impact the final outcome of the study. The data was successfully converted to one standard which allowed comparison of data between participants measured on the different Dopplers.

Limitations:

Each study has unique limitations. This study also experienced a few. The primary limitation is lack of generalizability due to a low powered study. Having a study with low power is both a risk of not finding the difference which is sought, but also possibly overstating one that is found. While this study reports important clinical findings, the results need to be used with caution due to the possibility of Type II error. Further, this study was intended to be able to predict which smokers would suffer the most complications due to smoking. This required a prospective longitudinal sample. When the methodology was changed to incorporate a retrospective dataset, this intent was no longer possible. These data though mixed with prospective and retrospective is heavily weighted to the latter. Therefore, the results should be considered more cross-sectional than prospective as was the original intent.

Power

The small sample size represents the most significant limitation on this research. The limited sample means this study is underpowered. This increases the possibility of a Type II error (false negative) which would accept a null hypothesis which is not true. The large variability on the length of rehabilitation among the participants increased the standard deviation of the data which possibly masked any true effect of tobacco on this variable. Upon reviewing the latter part of Table 5 it seems that smokers took longer than nonsmokers to reach every stage of rehabilitation but yet it was not significant. This is likely due to being low powered and unable to distinguish the difference between study effect and the normal variability in rehabilitation seen among people. This question would need to be replicated in a larger sample to determine what impact, if any, tobacco has on the length of rehabilitation.

Perhaps a higher validity risk is the significant findings on the first research question. According to Button et al. (2013) significant findings on underpowered studies could possibly overstate the significant findings which are seen. Button refers to this as the "winners curse". This essentially means that in order for an underpowered study to find significance, the difference needs to be exaggerated to overcome the normal variance and larger standard deviations seen in smaller samples. The results are not false but simply by chance alone, a sample was chosen which exaggerates the difference. This does not appear to be an issue with this study as the answer was similar in both the prospective and the retrospective datasets and the difference actually got larger with a the full datasets combined. This would seem to indicate the difference is real, and likely the true difference is fairly well represented in these findings as the two results are close together.

Retrospective Data

Including retrospective data was necessary in order to address the above limitation. By including existing data from another source, the sample size grew from 22 to 253. This was done to increase the sample size in an attempt to increase the power to detect difference between groups. However, retrospective data has its own significant limitations. Record accuracy is a

significant concern when using existing data for research. Of particular concern for this study are reports of conflicting accuracy for documentation of tobacco use in medical records. Some studies find the information accurate [31] but many others finding poor documentation of smoking status. [32-35] Fortunately for this study, the data set used was collected by a member of the research team who can verify the veracity of the data. A second limitation of using clinical data for research was the difference in collecting data for clinical outcomes versus research outcomes. While using clinical data for research purposes is legitimate, the validity has to be at least partially questioned due to the difference in collecting data with the intent of using the information for clinical purposes versus using the data for research purposes. A third limitation of retrospective data is the inability to determine cause and effect. While the data is technically longitudinal, determining cause and effect is problematic when viewing time in reverse. Furthermore, the control necessary to confidently state each participant's outcome is due solely to the study effect is impossible as the covariates which were controlled in the prospective arm could not be controlled in the retrospective arm. This raises the final limitation with this study. By using the retrospective data the concern over a low sample was addressed but the numerous covariates which were identified and measured in the prospective sample were not available. Because the markers which needed to be measured were not standard of care, they were not tracked as part of normal clinical care. The markers of nutrition (vitamin C), healing (hydroxyproline), perfusion (laser Doppler) and performance-based rehabilitation (two minute walk test) were all important to either controlling for confounders or else objectively measuring changes over time. While the lack of these do not invalidate the results of this work, it is a limitation and limits the confidence of the findings.

Conclusion:

It has been well established that tobacco is harmful to both wound healing as well as exercise tolerance. There exists less literature which addresses the unique challenges and outcomes experienced by the US military. There were no previous studies found which specifically addressed wound healing in a military population but one study did explore the effects of smoking on wound healing. [22] This current protocol maintained its uniqueness throughout the entire research timeline.

Injured SMs who smoke can expect longer healing times. This study found that those that smoke before the injury and during the healing phase can expect to heal, on average, about two months slower compared to those people who do not smoke. This result held for both the prospective and retrospective arms of the study. Slower healing means there is a greater opportunity for complications of the wound, as well as the delay in initiating rehabilitation. These delays ultimately mean a slower return to work timeline and increased lost productivity due to smoking cigarettes. Lost productivity in the military related to tobacco use has been seen in past studies related to increased illness [36] but there were no studies found which looked at the relationship between healing time of injured SMs who smoke and lost productivity. This study was able to quantify direct lost time due to delayed healing. The cost of this lost productivity needs to be explored in future studies

No significant difference was found in the rehabilitation times between smokers and nonsmokers. While the data did show smokers took longer to reach every milestone when compared to nonsmokers, the difference was not significant. However, the prospective arm of this study is known to be underpowered and the dates in the retrospective may not be precise. Therefore this question has not been adequately answered. There is ample evidence to show that

smokers have less exercise tolerance compared to nonsmokers so it would stand to reason that those results would carry over into the military population.

This study further developed the science into the care and rehabilitation of the injured SMs who experience an amputation. There has been much research conducted on this subpopulation over the course of the recent conflicts. This work further elucidates unique challenges experienced by these critically injured personnel. Healing among combat related traumatic amputations is complex given the mechanism of injury and the nature of the debris which is embedded into the wound. Smoking appears to further complicate this wound healing and place the SM at risk of further complications.

Future research needs to be conducted in this area. The current paradigm of offering cessation in a side clinic which requires many visits outside normal clinic visits does not seem to be working. Alternative methods of cessation need to be explored. With the advent of the Patient Centered Medical Home, embedded services need to be explored and standardized across the military. There has been much research conducted on minor surgeries and tobacco use but few studies on tobacco use among these critically injured service members. Military nurses are uniquely suited to address that question. And finally more research needs to be conducted on causes for and preventions of increased tobacco usage among those that deploy. The underlying causes and how to address those causes needs to be researched in more depth.

Significance of Study or Project Results to Military Nursing

This research is very important to military nursing practice, education and policy. While the topics of tobacco use, healing and rehabilitation covered in this research may not be uniquely military the intensity and volume of patients needing this care can only be found within the military. Military nurses have a long and rich history of helping to heal and mend critically injured service members.

This research reinforces the importance of comprehensive military nursing clinical practice and the need to determine tobacco use when assessing a military casualty. Tobacco use, while known to have ill-effect, has often been overlooked or passively accepted as normal behavior for deployed service members as a method of coping with deployment stress. This translates into poor documentation of smoking status in both nursing and provider notes in medical records as well as too few referrals for cessation assistance from nurses engaging in direct patient care. However, the data and clinical evidence are clear, tobacco use is detrimental to virtually every health outcome. This research reinforced the negative effects of tobacco use on healing. Nurses who are engaging in evidence-based practice and helping their patients achieve the best possible outcomes must strongly address tobacco use. Tobacco use remains higher among the very people who are suffering the most catastrophic injuries - predominantly Army and Marines who are on foot patrols in dangerous areas. Any current tobacco user will acknowledge the negative effects of smoking and about half wish to quit at any given moment. But nicotine is a physiological and psychological addiction and these people require assistance. Nurses, likewise, acknowledge the dangers of using tobacco. However, a simple audit of inpatient or outpatient charts will display the poor clinical practice applied to this knowledge. There are few discussions on smoking and few cessation referrals generated among those patients identified as smokers by nurses. A finding of tobacco use in a patient should be treated with the same concern as alcoholism, heroin addiction or other undiagnosed and/or untreated chronic illnesses. They all lead to morbidity and mortality. The significance of the findings of this study for military nursing is to reinforce the necessity of asking and then following up on tobacco use. It is never too late nor too early to quit.

Education is central to nursing care. Nurses are responsible for assessing patient needs, determining cultural and unique constraints, providing the patient with health information in a manner the patient can understand and to encourage healthy choices. Nursing is uniquely positioned to educate on tobacco use. The military has designated Public Health Nurses as the forefront of this educational campaign. There are many ongoing public educational campaigns both past and present which the Public Health nurses have used to address the tobacco problem in the military. While we have seen a slight drop in tobacco usage in the military, it still remains higher than our civilian counterparts. What we are currently doing is not working. This current study sought to enroll a group of smokers who were willing to quit after they were critically injured in order to show improved health outcomes. These SMs were well aware of the negative consequences of smoking but yet only one was able to quit for only a short amount of time before resuming smoking. While this study does not answer the difficult question of quitting, it does offer yet another piece to the difficult puzzle of what to do next. It is important to point out that smoking is an addiction. While this fact is loosely acknowledged, it is never truly addressed as an addiction. The military has an entire counseling service established to address drug addictions but yet tobacco use is not authorized treatment there. Nor are there any command referrals for tobacco use which has been shown to cause decreased productivity, increased sick call visits, or even increased injury rates. The data exists to show that tobacco use has as many

negative outcomes as alcohol use so it is difficult to understand why the two negative health behaviors are treated differently. If the health of the troops, a ready and able fighting force, and health promotion are truly the intent for the future, addressing tobacco use should be the number one item which will have the largest and most profound effect on overall health.

Tobacco policy in the military is confusing. There are many educational signs posted and occasional classes given but overall, the behavior is accepted. Only the Navy has gone to the step of stating that anyone seen smoking in uniform is subject to punishment. This clearly sets the expectation and attempts to disconnect smoking from military service. This places tobacco use on par with alcohol use - neither can be used while in uniform. Tobacco use in the military has been studied well enough to be certain of the negative effects on productivity, health and retention. Research exists which shows tobacco use increases medical costs both in the near term and chronic care. The burden of education for chronic illnesses, long-term care, and disease management typically falls to nursing to evaluate, coordinate and manage. A great example can be seen in cardiac nurses who have developed programs to monitor congestive heart failure patients, maintain contact with the patients outside the hospital and even establish nurse-run clinics to help maintain community based control of these patients. There are nurse-run tobacco cessation clinics which have been set up to address the issue of tobacco addiction in the military. However, these clinics tend to be self-referral, not always clearly affiliated with primary care and continuity is poor due to patients dropping out of the programs. Perhaps it is time for a policy change that treats all addiction in the same manner. Anyone who is seen in a military facility and diagnosed with nicotine addiction should be referred to these nurse-run cessation clinics, using a similar model as the congestive heart failure clinic or even the drug and alcohol referral service currently in place. Often the argument is made that tobacco is legal and therefore cessation cannot be mandated. It should be noted that alcohol is also legal but is very tightly regulated by the military such that even smelling of alcohol, with or without proven addiction, is sufficient grounds for a referral. This should be the same standard nurses apply to tobacco use which has been shown to have much worse outcomes than occasional alcohol use. Not until nurses begin to view tobacco addiction as a true drug addiction will the policy change. Military nurses currently control much of the tobacco cessation programs now. Therefore it is incumbent upon military nurses to advocate for a dramatic policy change to address this silent drug addiction which is too prevalent in our otherwise young, healthy and athletic military members.

The relevance to military nursing of this current project is to offer yet more credible evidence to the negative consequences of continued tobacco use in the military. Nursing is uniquely situated and equipped to directly address this negative health behavior and clinical addiction. This is a simple call to action for nurses to begin to take tobacco use more seriously and view it as a drug addiction with clear and present negative health consequences in both the short and long term.

Changes in Clinical Practice, Leadership, Management, Education, Policy, and/or Military Doctrine that Resulted from Study or Project

The amputee wound care specialist has been integrally involved in this research. The significant and negative influence of tobacco use has been validated through this work. These findings impressed upon the wound care specialist the importance of strongly encouraging smoking cessation into his clinical care. While it has been known that tobacco use increases the likelihood of wound complications, this work is the first to offer quantitative information that can be used during patient counseling among patients with a new amputation to increase interest in smoking cessation.

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Summary of Dissemination

Type of Dissemination	Citation	Date and Source of Approval for Public Release
Publications		
Publications in Press		
Published Abstracts		
Podium Presentations	Effect of Smoking Cessation on Healing Rehabilitation – accepted for poster presentation at the AMSUS Karen Rieder/Federal Nursing Service Poster Session, Phoenix, Arizona – November 2012 (conference cancelled) Won Award	BAMC DCI and PAO 12 July 2012
	Effect of Smoking Cessation on Healing and Rehabilitation- Podium presentation at the 2012 Uniformed Services University Research Day, Bethesda MD- May 2012	BAMC DCI and PAO June 2013
Poster Presentations	Effect of Smoking Cessation on Healing and Rehabilitation – poster presentation at the 17th Biennial Phyllis J. Verhonick Conference, San Antonio, Texas – April 2012	BAMC DCI and PAO 18 April 2012
Media Reports		
Other		

Reportable Outcomes

Reportable Outcome	Detailed Description
Applied for Patent	None
Issued a Patent	None
Developed a cell line	None
Developed a tissue or serum repository	None
Developed a data registry	None

Recruitment and Retention Table

Recruitment and Retention Aspect	Number
Subjects Projected in Grant Application	100
Subjects Available	253
Subjects Contacted or Reached by Approved Recruitment Method	253
Subjects Screened	253
Subjects Ineligible	2
Subjects Refused	7
Human Subjects Consented	22
Subjects Who Withdrew	1
Subjects Who Completed Study	21
Subjects with Complete Data	10
Subjects with Incomplete Data	11

Demographic Characteristics of the Sample

Characteristic	
Age (yrs)	31.9 ± 5.8
Women, n (%)	4 (1.6)
Race	
White, n (%)	192 (75.9)
Black, n (%)	21 (8.3)
Hispanic or Latino, n (%)	1 (0.4)
Native Hawaiian or other Pacific Islander, n (%)	0 (0)
Asian, n (%)	4 (1.6)
Other, n (%)	2 (0.8)
Military Service or Civilian	
Air Force, n (%)	12 (4.8)
Army, n (%)	199 (79.0)
Marine, n (%)	34 (13.5)
Navy, n (%)	7 (2.8)
Civilian, n (%)	0 (0)
Service Component	
Active Duty, n (%)	253 (100)
Reserve, n (%)	0 (0)
National Guard, n (%)	0 (0)
Retired Military, n (%)	0 (0)
Prior Military but not Retired, n (%)	0 (0)
Military Dependent, n (%)	0 (0)
Civilian, n (%)	0 (0)

Final Budget Report

Attach and sign the official final budget from your applicant organization. Your signature indicates that you carefully reviewed the official final budget and agree with it. If applicable, briefly describe the rationale for and outcome of reallocating funds and/or obtaining additional funds. If applicable, explain reason(s) for remaining funds.

TASK BUDGET SUMMARY

HENRY M. JACKSON FOUNDATION FOR THE ADVANCEMENT OF MILITARY MEDICINE

Advancing Military Medical Research

Current as of: SEP2015

Organization: HJF-Henry M. Jackson Foundation
Award #/Name: 63930 - EFFECT SMOKING CESSATION
Award Manager: LEWIS, PAUL
Award Period: 09/01/2012 to 06/30/2014
Project #/Name: 306219 - EFFECT SMOKING CESSATION
Project Manager: LEWIS, PAUL
Project Period: 09/01/2012 to 06/30/2014

Task # / Name: 1.00 - EFFECT SMOKING CESS
Task Period: 09/01/2012 to 06/30/2014
Task Manager: LEWIS, PAUL
Award Sponser: UNIFORMED SERVICES UNIVERSITY OF THE HEALTH SCIENCES
Billing Analyst: DORSEY, TRACEY
Primary Analyst: LIVAN, REYHAN
Ref Award#: HU0001-09-1-TS08

Current As of	Award/Project/Task Number	Task Budgetary Control	Category Group	Expenditure Category	Budgetary Control	Current Month Expenses	Budget	Open Commitment	Task-To-Date Expenses	Total Funds Used	Balance Available	Percentage Available
09/13/2015	63930 - 306219 - 1.00	Advisory	DIRECT	PERSONNEL	Advisory	0.00	151,774.00	0.00	125,385.81	125,385.81	26,388.19	17.39
				CONSULTANTS	Advisory	0.00	27,850.00	0.00	0.00	0.00	27,850.00	100.00
				EQUIPMENT	Advisory	0.00	2,947.00	0.00	0.00	0.00	2,947.00	100.00
				SUPPLIES	Advisory	0.00	81,084.00	0.00	51,868.65	51,868.65	29,215.35	36.03
				DOMESTIC TRAVEL	Advisory	0.00	19,142.00	0.00	7,252.76	7,252.76	11,889.24	62.11
				PARTICIPANTS	Absolute	0.00	300.00	0.00	250.00	250.00	50.00	16.67
				OTHER DIRECT COSTS	Advisory	0.00	18,213.00	0.00	36.80	36.80	18,176.20	99.80
				TOTAL DIRECT :		**0.00**	**301,310.00**	**0.00**	**184,794.02**	**184,794.02**	**116,515.98**	**38.67**
			INDIRECT	USU OFF-SITE OVERHEAD	Advisory	0.00	6,177.00	0.00	3,892.90	3,892.90	2,284.10	36.98
				COMPANY-WIDE G & A	Advisory	0.00	42,093.00	0.00	26,081.22	26,081.22	16,011.78	38.04
				TOTAL INDIRECT :		**0.00**	**48,270.00**	**0.00**	**29,974.12**	**29,974.12**	**18,295.88**	**37.90**
				TOTAL TASK :		**0.00**	**349,580.00**	**0.00**	**214,768.14**	**214,768.14**	**134,811.86**	**38.56**

14 Sept 2015

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